United States Patent

[11] 3,594,887

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[45] Patented **July 27, 1971**

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[54] **APPARATUS FOR ELECTRICALLY CONNECTING PAIRS OF CONDUCTORS**
7 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** ..... **29/203 D,** 29/203 HC
[51] **Int. Cl.** **H01r 43/04**
[50] **Field of Search** ..... 29/203, 206, 203 HC, 203 H; 140/111

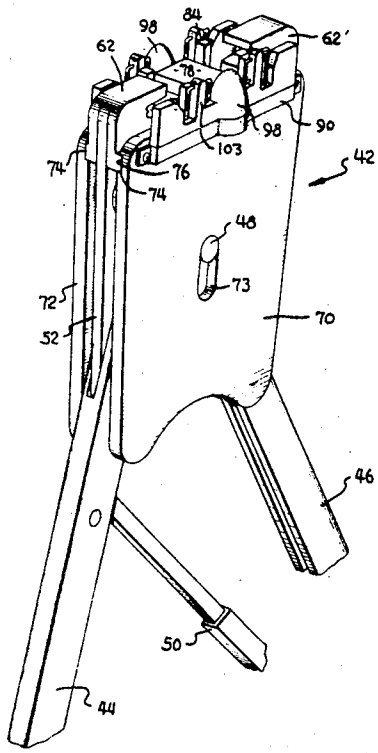
[56] **References Cited**

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3,426,355	2/1969	Over	29/203
3,431,621	3/1969	Gurley et al.	29/203
3,438,407	4/1969	Over	140/111

Primary Examiner—Thomas H. Eager
Attorneys—Curtis, Morris and Safford, William J. Keating, William Hintze, Frederich W. Raring, John R. Hopkins, Adrian J. LaRue and Jay L. Seitchik

ABSTRACT: Corresponding wires of two pairs of wires (e.g. twisted pairs) are connected by an apparatus which separates the wires of the pairs from each other at a location adjacent to the wire ends. The wires of the two pairs are positioned against each other in the apparatus and individual electrical connections are effected between corresponding wires of the groups. End portions of the wires which extend beyond the electrical connections are cut off and removed.



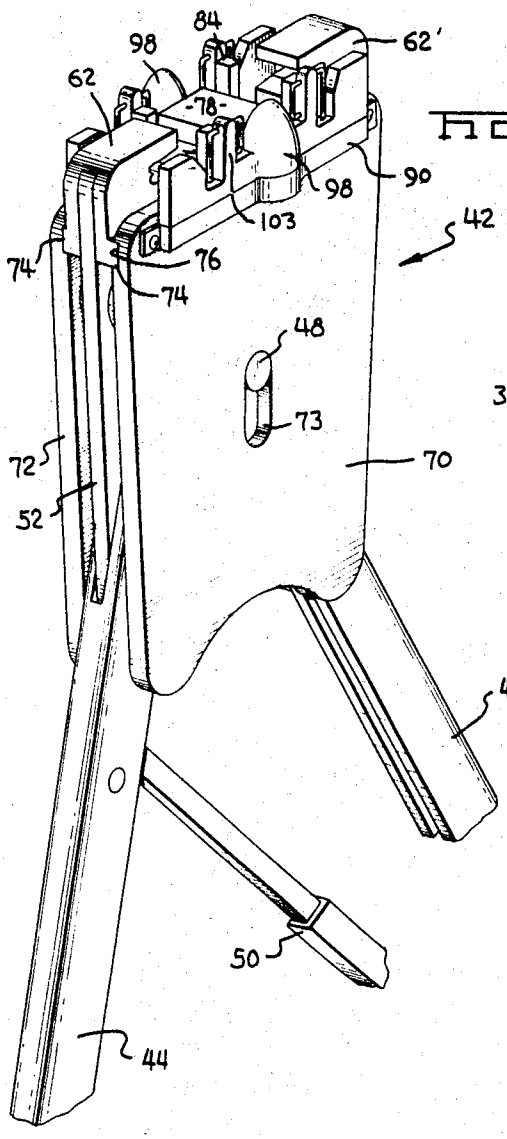


Fig. 1

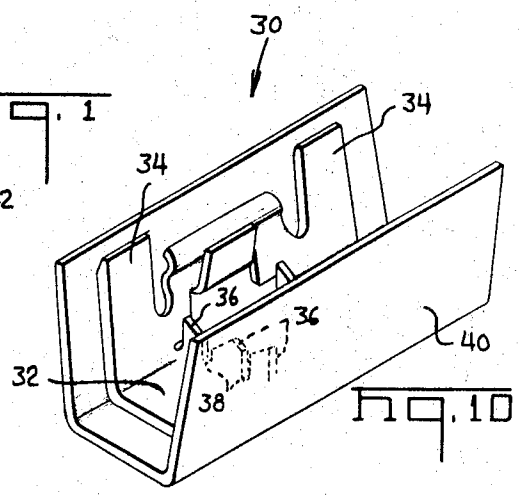
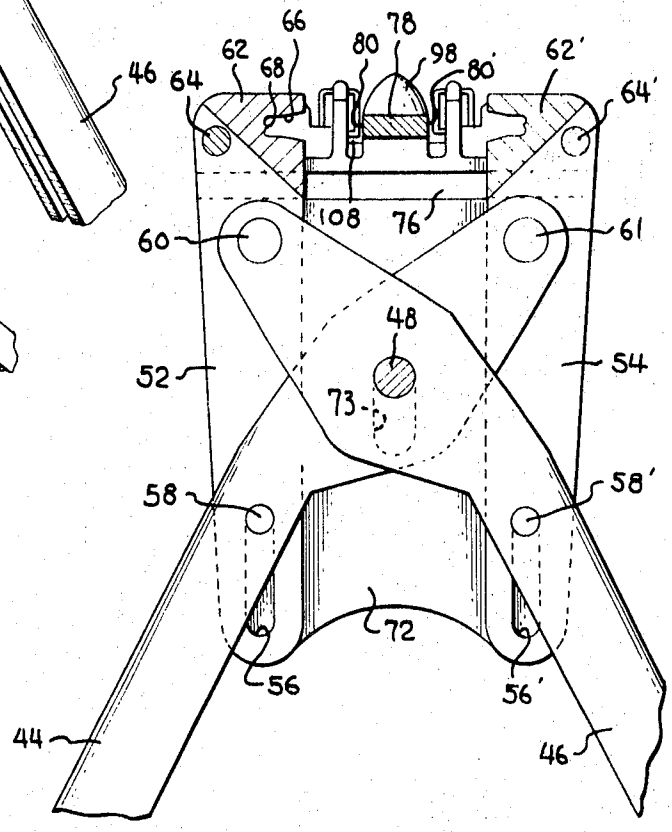


Fig. 1a

Fig. 2



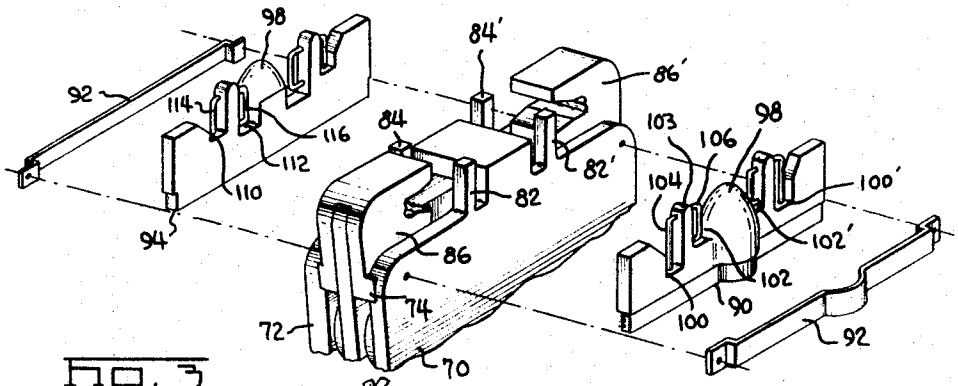

98
84'
86'
92
114
116
84
103
106
98
112
82'
104
100'
110
82
102'
94
86
102
74
90
72
100
92
70

Fig. 3

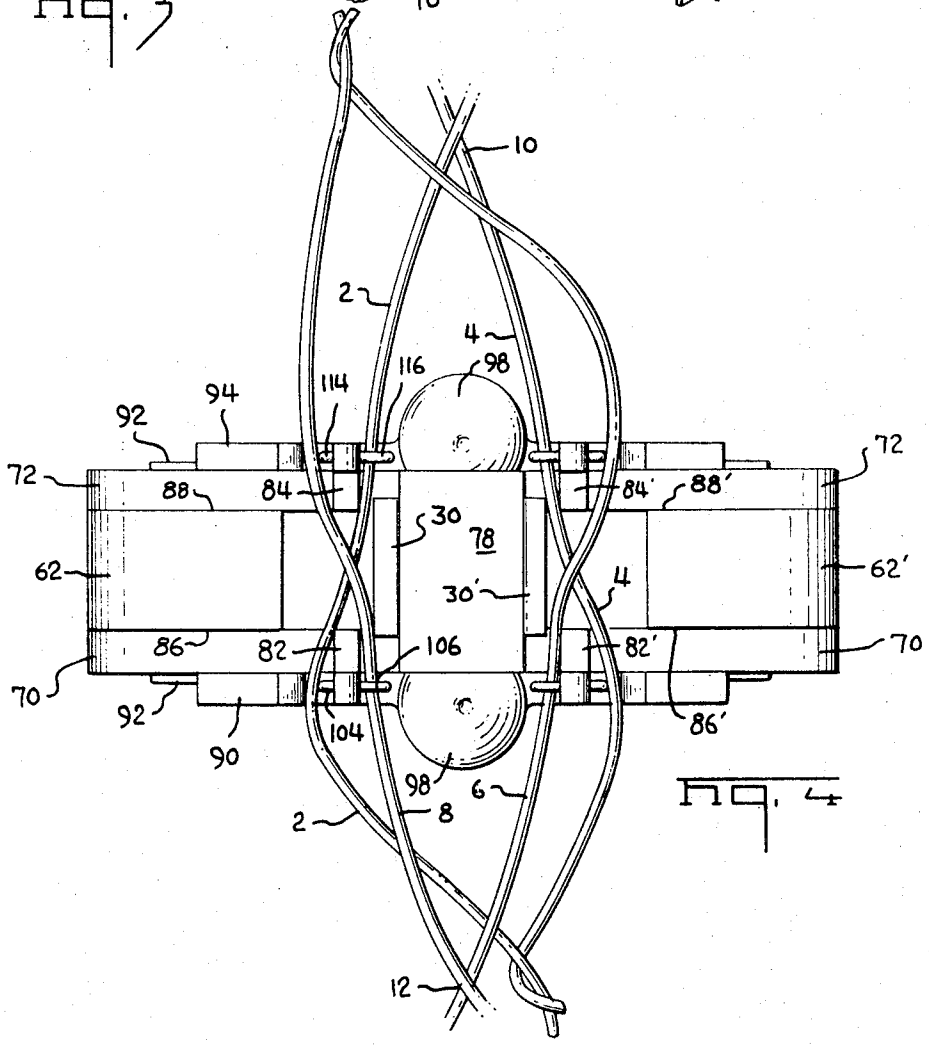

10
2
4
116
98
114
94
92
72
72
88
84
84'
88'
30
78
62
62'
30'
4
86
82
106
82'
70
70
92
104
86'
90
98
6
2
8
12

Fig. 4

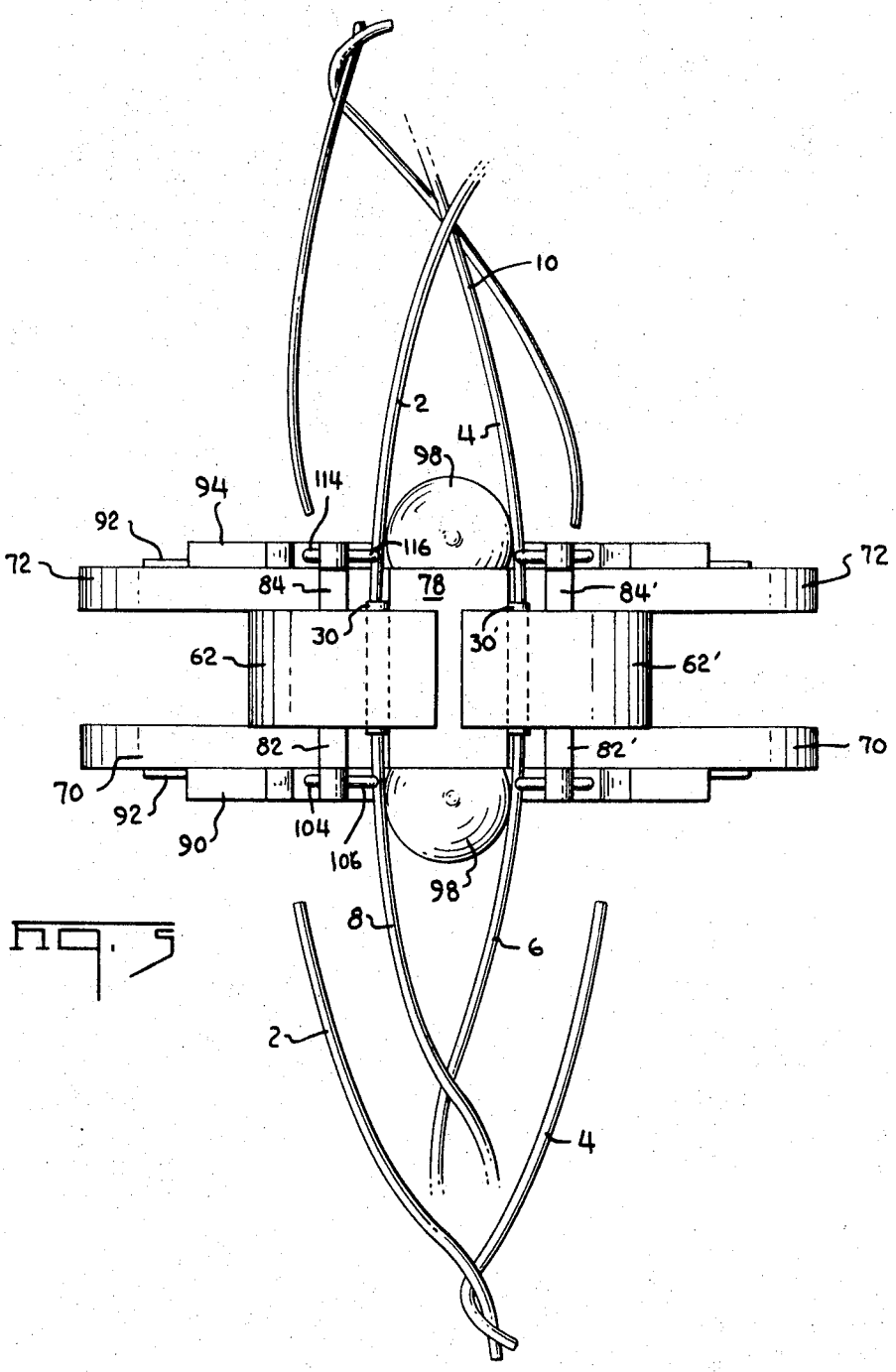

10
2
4
98
94
114
92
116
72
84
78
84'
72
30
30'
62
62'
82
82'
70
70
92
90
104
106
98
8
6
2
4

Fig. 5

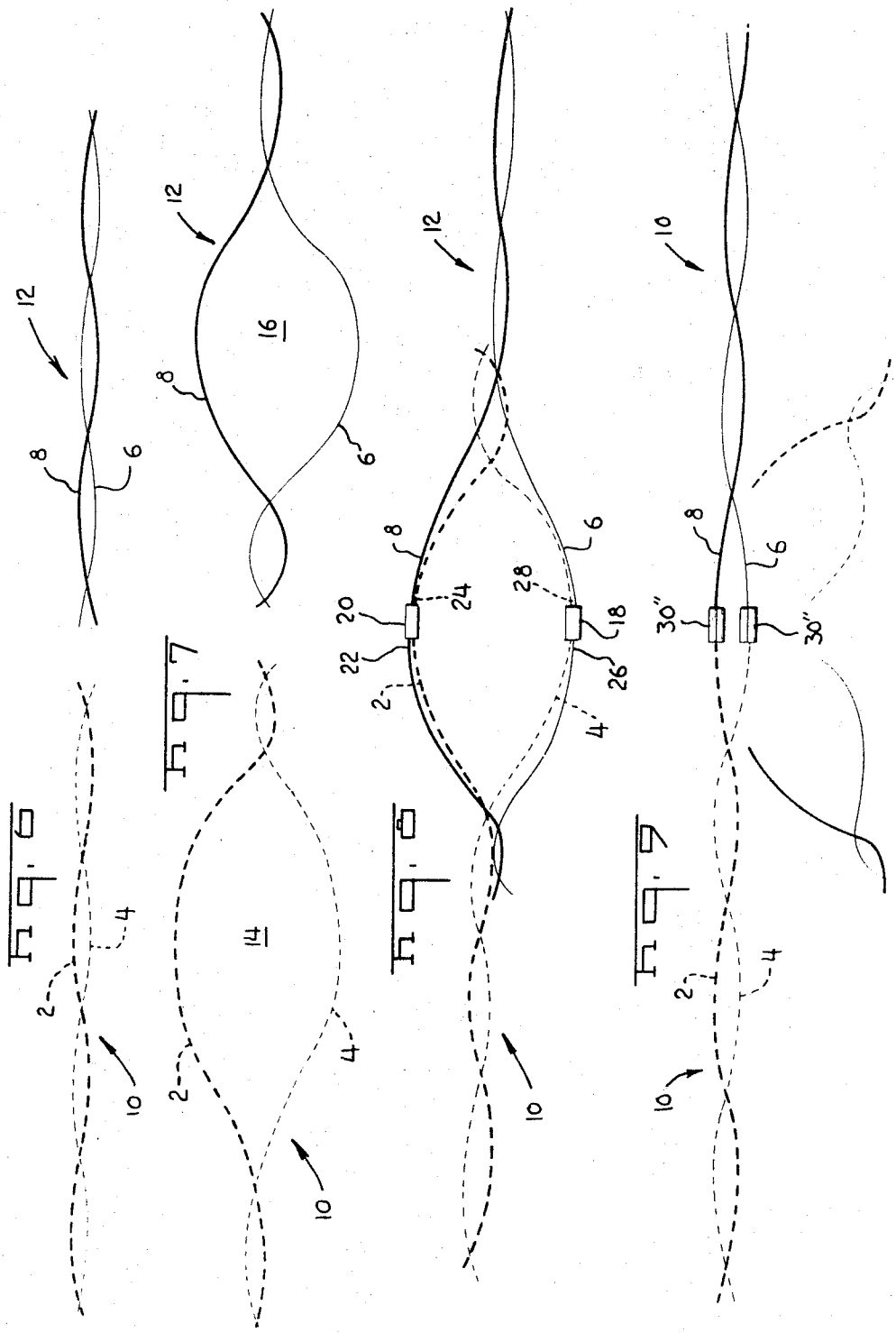


FIG. 6

FIG. 7

FIG. 8

FIG. 9

APPARATUS FOR ELECTRICALLY CONNECTING PAIRS OF CONDUCTORS

RELATED INVENTIONS

This application is a division of application Ser. No. 596,672, **filed Nov.** 23, 1966, and now U.S. Pat. No. 3,438,407.

This invention is also related to the inventions described and claimed in the following U.S. applications and patents.

Serial No.	Filing Date	Inventor	U.S. Pat. No.
782,596	Dec. 10, 1968	F. P. Dola et al.	
673,856	July 23, 1968	S. L. Parsons	3,406,247
573,078	Aug. 17, 1966	W. R. Over	3,426,355
625,096	Mar. 22, 1967	G. M. Gurley et al.	3,431,621
432,621	Feb. 15, 1965	J. E. Marley et al.	3,320,354

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for connecting the corresponding wires of two groups of wires which extend axially towards each other. The invention is herein disclosed with reference to the splicing of the corresponding wires of two twisted pairs of wires of the type commonly used in the telephone industry. However, alternative uses of the invention will be apparent to those skilled in the art.

The conductors used in the telephone industry are ordinarily provided in cables, each of which contains a number of wire pairs. The pairs are helically twisted together and are commonly referred to as twisted pairs. The larger cables contain as many as 2,700 pairs or 5,400 individual wires. The two wires of each twisted pair cooperate with each other, for example, one wire may function as a ringing conductor and the other wire may function as a signal conductor. The lineman who service such cables think of the conductors in the cable in terms of pairs rather than in terms of individual wires. When two ends of a telephone cable are spliced to each other, a given pair in one end must be connected to the corresponding pair of the other end, and quite often, the corresponding wires of the pairs must be connected to each other selectively rather than indiscriminately. Ordinarily, the pairs are color-coded, for example, one wire having red insulation and one wire having white insulation so that the lineman making connections can readily connect the red wire of the one end of the cable to the red wire of the other end, and the white wire of the one end of the cable to the white wire of the other end of the cable.

It is among the objects of the present invention to provide an improved apparatus for connecting the corresponding wires of two pairs of wires in one operation. It is a further object of the invention to provide an improved apparatus for connecting the corresponding wires of two groups of wires to each other. A still further object is to provide an apparatus for splicing or connecting twisted pairs of wires in which the technician or lineman treats or handles each pair as a single unit rather than as two individual wires. A still further object is to provide an apparatus for connecting pairs of wires in which excess wire in the two pairs is trimmed at the time the connection is made and disposed of in an operation which is carried simultaneously with the connecting operation. A still further object is to provide an improved crimping apparatus for connecting twisted pairs of wires.

These and other objects of the invention are achieved in a preferred apparatus embodiment comprising first and second wire connecting means, each of which is capable of making a lap-type connection between two wires. The wire connecting means are disposed in side-by-side relationship and means are provided at each end of each connecting means for selectively severing one of the two wires connected by the connecting means. Guide means are provided for locating the individual wires of each pair in one of the connecting means so that one wire from each pair will be located in each of the two connecting means. Upon actuation of the connecting means, the corresponding wires of the two pairs are connected to each other and the scrap wire which extends beyond the connecting means to the wire ends is trimmed at a location adjacent to the connecting means and disposed of. In accordance with the method aspect of the invention, the two wires in each of the two pairs are separated at a location adjacent to their ends, thus forming gaps or open spaces in the ends of the two pairs. The two pairs are then positioned adjacent to each other with their gaps coinciding and with their corresponding wires extending parallel to, and beside, each other. Electrical connections are made by any suitable method on each side of these gaps and the scrap wire which extends beyond the electrical connections is disposed of. The electrical connection can be made by any suitable method, for example, crimping or welding.

In the drawings:

FIG. **1** is a perspective view of one form of apparatus for connecting pairs of wires in accordance with the invention;

FIG. **2** is a sectional side view of the tool of FIG. **1** showing the crimping dies in their open or separated positions;

FIG. **3** is a perspective exploded view showing the upper portion of the tool of FIG. **1**;

FIG. **4** is a top plan view of the tool shown in FIG. **1** showing the crimping dies in their separated or open positions and showing the wires of two pairs of conductors positioned in the tool at the beginning of an operating cycle;

FIG. **5** is a view similar to FIG. **4** but showing the positions of the parts at the conclusion of the operating cycle after the wires have been connected and the excess scrap wire has been trimmed from the wire ends.

FIG. **6** is a schematic view showing two twisted pairs of wires which are to be connected to each other;

FIGS. **7** and **8** schematically illustrate the steps for connecting the wires of FIG. **6** in accordance with the method aspect of the invention;

FIG. **9** is a perspective view of a splice between the corresponding wires of the twisted pairs of FIG. **6**; and

FIG. **10** is a perspective view of one form of crimpable electrical connector which is used with the tool shown in FIG. **1**.

Referring first to FIGS. **6—8**, the reference numeral **10** denotes a twisted pair of conductors **2, 4**, which are to be connected to a second twisted pair **12** comprising conductors **6, 8**. Twisted pairs of conductors are commonly used in the telephone industry for ease of identification of the individual wires in a cable and when connections are made between two cable ends, a specific conductor in one pair must be connected to a specific conductor of the other. Thus, in FIG. **6**, it can be assumed that the conductor **2** of pair **10** is a signal conductor and must be connected to the signal conductor **8** of the pair **12**. The ground conductor **4** of the pair **10** thus must be connected to the ground conductor **6** of the pair **12**.

In accordance with the method aspect of the present invention, the conductors **2, 4** of the pair **10** are separated or pulled apart at a location adjacent to their ends to form a gap **14**. The conductors **6, 8**, of the pair **12** are similarly pulled apart to form a gap **16**. Where using the herein disclosed embodiment of the invention, I prefer to leave the end portions of the conductors of the two pairs intertwined as indicated for convenience in handling. When using alternative embodiments, it is sometimes preferable to separate the pairs entirely. The two pairs **10, 12** are next positioned against each other as shown in FIG. **8** with the gaps **14, 16** substantially coinciding with each other and with the conductor **4** extending alongside the conductor **6** and with the conductor **2** extending along side the conductor **8**. The conductors **6, 4** crimped then connected to each other at **18**, that is, at a point midway between the ends of the gaps **14, 16** and the conductors **2, 8** are similarly connected at **20**. The electrical connections **18, 20** can be made in any suitable manner. There is described below a preferred

form of handtool for making crimped connections at **18** and **20** although the connections may be made by welding or any other method involving mechanical interlocking crimping or bonding. Concomitantly with making of these connections **18**, **20**, the end portions of all of the conductors which extend beyond the electrical connections are trimmed as indicated at **22**, **24**, **26**, and **28**. The completed splice between the pairs **10**, **12**, is shown in FIG. **9** with the electrical connections **30''** being crimped connections of the type which will be described below.

A salient advantage of the invention as described immediately above is that the individual pairs **10**, **12** are treated as units even though each pair comprises two wires. An immediate benefit which accrues from this fact is that the production rate of the lineman connecting the individual pairs in a multipair cable is substantially increase since he does not handle the wires individually. Thus the time required to form the gaps **14**, **16** and to superimpose the gaps on each other as shown in FIG. **8** is about the same as would be required to position tow individual wires of the pairs in a suitable hand tool or other connecting device for forming a single connection. A further advantage of the invention as broadly described above is that the time required to identify the pairs being connected is substantially reduced. Thus, if the lineman identifies the pair **10** in one bundle or cable and the pair **12** in the other, he has completed the identification process for connecting the wires of those two pairs and he need only superimpose the separated portions of the pairs in the proper manner and connect the corresponding wires to each other, that is, the ground wire of pair **10** to the ground wire of pair **12** and the signal wire of pair **10** to the signal wire of pair **12**. The overall result is a substantial time saving and a corresponding increase in the productivity of the technician.

FIG. **1** shows one form of hand tool **42** which can be used to practice the method of FIG. **6—8** and to form crimped connections between the corresponding wires of the pairs. These crimped connections are made with connectors **30** (FIG. **10**) each of which has a U-shaped metallic channel portion comprising a web **32** and sidewalls **34**. A pair of spaced apart tongues **36** are struck up from the web **32** and these tongues have parallel notches **38** which extend downwardly from their upper edges. The notches **38** have a width substantially equal to, or slightly less than, the diameter of the conducting cores of the wires which are to be connected so that when the wires are forced into the notches, the insulation of the wires will be penetrated by the edges of the notches. The metallic cores of the wires will then make electrical contact with the tongues and, therefore, with the connectors. In use, the two wires which are to be connected to each other are positioned between the sidewalls **34** in overlapping side-by-side relationship with each wire being disposed above a pair of aligned notches **38** of the tongues **36**. The sidewalls **34** are then bent inwardly to force the wires downwardly into the notches and form the crimped connections. Advantageously, insulation is provided on the external surface of the connector, the disclosed connector having a film **40** of suitable plastic which extends axially beyond the end of the connector and upwardly beyond the edges of the sidewalls so that the finished crimped connections will be completely insulated. Further details of connectors of the type shown in FIG. **10** are set forth in U.S. Pat. No. 3,426,355, referred to above.

The tool **42** has a pair of crossed handles **44**, **46** which are pivoted together at **48** adjacent to their upper ends. The handle **46** is bifurcated at its upper end and its two ears straddle the upper end portion of the handle **44**. Both handles have generally channel-shaped cross sections for reasons which will be apparent from the description presented below of the tool head. Advantageously, a full-stroke-compelling mechanism **50** is mounted between the handles as disclosed in U.S. Pat. No. 2,618,993, to ensure that after the beginning of an operating cycle, the technician will close the handles to the limit of their travel so that the operation will be completely carried out.

Mounting plates or bars **52**, **54** are pivotally connected at **60**, **61** to the upper ends of the handles **46**, **44**. These mounting bars or plates extend downwardly through suitable openings in the handles and have elongated slots **56**, **56'** in their lower ends. Pins **58**, **58'** are provided in the handles **44**, **46** and extend through slots **56**, **56'** to permit relative upward movement of the bars **52**, **54** with respect to the handles during movement of the handles relatively towards each other.

The head portion of the tool **42** has a pair of back-to-back crimping mechanisms thereon which are, in many respects, identical to each other. Accordingly, the same reference numerals, differentiated by prime marks, will be used to identify the corresponding parts of the two mechanisms and only the mechanism which appears on the left in FIG. **2** will be described in detail. The crimping mechanism on the right will be described to the extent necessary for an understanding of operation of the tool.

A die block **62** is mounted on the upper end of plate or bar **52** by means of a pin **64**, the upper end of the bar or plate **52** extending into a suitable slot in the die block and the pin **64** extending through the die block and through the upper end portion of the plate **52**. Die block **62** has on its right-hand side, as viewed in FIG. **2**, a forming recess or cavity **66**. This forming recess or cavity has generally convergent sidewall portions which merge into substantially parallel sidewall portions and which at their inner end are reversely curled towards each other to form a cusp **68**. The width of this forming recess is slightly greater than the width of the connector **30** so that when the die moves relatively over the connector, the connector sidewalls will be bent inwardly towards each other and then towards the connector web. Details of this type of crimping die are more fully described in the above-identified U.S. Pat. Nos. 3,426,355 and 3,320,354.

The head portion of the tool is contained between side plates **70**, **72**, the previously identified pivot pin **48** extending through elongated slots **73** in these side plates **70**, **72** to permit closure of the handles and relative upward movement of the side plates and the head. The die block **62** has laterally extending flanges **74** which are received in suitable grooves or guideways **76** on the opposed surfaces of the side plates **70**, **72**, an arrangement which permits the die blocks **62**, **62'** to move relatively towards each other when the handles are closed. The connectors which are to be crimped onto the wires are supported on surfaces **80**, **80'** of an anvil **78** which is integral with, and extends between, the side plates **70**, **72** directly above the pivot pin **48**. The connectors **30** positioned on the surfaces **80**, **80'** thus face the forming surface portions **66**, **66'** of the die blocks as will be explained more fully below.

A shear bar **82** in integral with, and extends from, the upper side or edge of the plate **70** in spaced relation to the surface **80** and between this surface and the right-hand end of the die block **62** when this die block is in its retracted position (FIG. **3**). A corresponding shear bar **84** is provided at the same location on the plate **72**, these two shear bars **82**, **84** being in alignment with each other on opposite sides of the die block. Corresponding shear blocks **82'**, **84'** are provided on the right-hand side of the plate as best shown in FIG. **3**. These shear bars **82**, **84** cooperate with sides **86**, **88** of the die block to shear the wires concomitantly with crimping as will be explained below.

In order to facilitate the positioning of the wires in the tool, I provide a guide member, blocks **90**, **94**, which may be of molded plastic such as polyurethane or the like and which are held against the plates **70**, **72** by suitable brackets **92**. These two guide members are similar to each other excepting for the depth of various wire-receiving slots on their upper sides as will be explained more fully hereinbelow.

The guide member **90** and the guide member **94** both have centrally located generally conical bosses **98** intermediate their ends which are disposed on each side of the anvil block **78**. The guide member **90** has two notches **100**, **102** on the left-hand side of the boss **98**, the notch **100** being relatively deeper than the notch **102** and the two notches being

separated by an upwardly extending projection **103** of the molding. A short section of bent wire **104** is mounted in the notch **100** and extends downwardly and into the floor or base of this notch as shown in FIG. **3** to reduce the effective width of the notch into which the wire is placed and to accurately locate the wire in the notch. A short section of wire **106**, which is U-shaped in this case, is provided in the notch **102** and has its legs extending into the sides of the projection **103**. This arrangement in the notch **102** provides a space indicated at **108**, FIG. **2**, in the base of the notch between the upper surface of the notch and the lower side of the wire guide member **106**. This space should be sufficient to permit one of the wires being connected to move against the side of the projection **103** for reasons which will be apparent from the description of operation given below.

The notch **102'** is substantially similar to the notch **102** and the notch **100'** is similar to the notch **100** excepting, of course, that these notches **102'**, **100'** face in the opposite direction from the notches **100**, **102**.

The guide member **94** has notches **110**, **112** on the left (as viewed in FIG. **3**) of the boss **98**. In this instance, however, the notch **110** (which is remote from the boss **98**) is relatively shallow while the notch **112**, which is adjacent to the boss **98**, is relatively deep. The wire guide members **114**, **116** are in other respects similar to the previously identified guide member **104**, **106**. Again, the notches **110'**, **112'** are similar to the notches **110**, **112**.

The operation of the disclosed tool embodiment of the invention is as follows. The parts at the beginning of the operating cycle will be in the positions shown in FIGS. **1**, **2**, and **4** with the die blocks **62**, **62'** in their remote positions with respect to the anvil-supporting surfaces **80**, **80'** and with the handles **44**, **46** in their open conditions. The operator first separates the two wires of the pair **10** at a location adjacent to the ends as generally illustrated in FIG. **7**, and as more specifically shown in FIG. **4**. He then lowers the separated portion of the pair **10** over the head of the tool with the wire **2** extending on the left (as viewed in FIG. **4**) of the bosses **98** and with the wire **4** extending to the right of these bosses. The wire **2** is located in the notches **112**, **100**, that is, the deep notches on the left-hand side of the tool as viewed in FIG. **4**. He similarly locates the wire **4** in the notches **112'**, **100'**, that is, the deep notches on the right-hand side of the tool. The technician then picks up the pair **12**, forms a gap adjacent to the end of the pair by separating the two wires, and moves this pair over the bosses **98** with the wire **8** to the left of the bosses **98** in FIG. **4** and with the wire **6** on the right-hand side of the bosses. The wire **8** is located in the notches **102**, **110** and the wire **6** is similarly located in the notches **102'**, **110'**. These wires, **6**, **8** are thus located in the shallow notches. The operator then positions connectors **30**, **30'** on the anvil surfaces **80**, **80'** with the web portions of the connectors supported on the surfaces and with the sidewalls facing the forming cavities **66**, **66'**, of the dies. Finally, the operator squeezes the handles **44**, **46** causing the die blocks **62**, **62'** to simultaneously move towards each other and towards the forming surfaces **80**, **80'** of the anvil **78**. During initial movement, the sides **86**, **88**, **86'**, **88'**, of these die blocks move relatively past the shearing members **82**, **84**, **82'**, **84'**, and the projecting end portions of all of the wires are severed. The scrap wire end shown in FIG. **5** fall away or are removed from the working area. During further movement of the die blocks relatively towards the supporting surfaces, the wires are moved relatively between the sidewalls **34** of the connectors positioned on the anvil-supporting surfaces and the sidewalls of the connectors are thereafter bent towards the connector webs to force the wires into the notches **38** of the tongues **36** and establish the electrical connections.

The reentrant spaces **108** between the U-shaped wire guide in the notches **102**, **102'** and **112**, **112'** are provided in order that the wires might be located as shown in FIG. **4** such that the portions of the wire entering the tool will not bear against, or interfere with, the connectors **30**, **30'** supported on the anvil surfaces. In other words, the technician moves the wires downwardly over the bosses **98** and then into the spaces **108** until they occupy the positions shown in FIG. **4**. The wire guide members **106**, **116**, **106'**, **116'** also function to retain the wires in the position shown in FIG. **4**.

The provision of the alternate shallow and deep slots **100**, **102**, etc. in each of the guide blocks **90**, **94** ensures that the wires in each of the two crimped connections **30''** in FIG. **9** will be side by side rather than superimposed on each other or crossing each other. For best results with the connector of the type shown in FIG. **10**, the wires should extend parallel to each other and in side-by-side relationship in the connector sidewalls.

The advantages of the method as explained above are generally applicable to the tool of the type shown in FIGS. **1–5** or to any other tool which can be used to carry out the method. With this tool, the scrap wire which extends beyond the electrical connections formed is immediately eliminated when the connections are made and during the same operation which is required to make the connection. The fore going description of the structure and operation of the tool illustrates the fact that in accordance with the method and in accordance with the principles of the tools disclosed, the technician handles each pair **10**, **12** as a unit so that each operation he performs contributes to the electrical connections between four wires rather than between two wires as with prior art methods.

It will be noted that in the disclosed tool embodiment of the invention, the two crimping mechanism in the tool head are disposed parallel to each other (i.e. such that the connectors **30**, **30'** in these crimping mechanisms extend parallel to each other) and back to back. This arrangement is convenient for many types of tools but other arrangements might be employed with different types of tool linkages. For example, the crimping mechanisms can be arranged with their axes in side-by-side parallel relationship and facing in the same direction rather than back to back. It would be necessary with an alternative arrangement of the crimping mechanisms to provide a wire-guiding device which would locate the wires properly in the tool so that the ends would be trimmed as explained above when the connectors are crimped.

In the embodiment of the invention described above, the two pairs **10**, **12** are assumed to extend towards each other, the condition which commonly exists when the pairs in two ends of a telephone cable are being spliced. The principles of the invention can also be employed where the two pairs extend beside each other. Under such circumstances, all four wires **2**, **4**, **6**, and **8** would be cut on the same side of the electrical connections (i.e. between the electrical connections and the wire ends). The resulting splices or connections would be butt connections with the two wires in each connection extending in the same direction from the connection. A tool for making such butt connections could be generally similar to the tool shown in the drawing except that all of the wires would extend into the tool from the same side and the wires would be cut on the remaining side. For example, the tool of FIGS. **1—3** could be used to make butt splices between the corresponding wires of two pairs if two of the wires were placed in notch **102** with their ends extending through the notch **110**. The remaining two wires would be positioned in the notch **102'** with their ends extending through the notch **110'**. All of the wires would be severed in the plane of the left-hand side (as viewed in FIGS. **1** and **3**) of the die blocks **62**, **62'** but would not be cut in the plane of the right-hand side of these die blocks. The notches **102**, **110**, **102'**, **110'** would be modified to accommodate two wires rather than a single wire.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

I claim:

1. Apparatus for connecting the corresponding wires of a first and second pair of wires to each other comprising

first and second wire-connecting instrumentalities, each of said wire connecting instrumentalities being capable of connecting two wires to each other said wire-connecting instrumentalities being disposed in side-by-side relationship and having severing means for selectively severing wire ends which extend through said connecting instrumentalities, and

separator and guide means between said two connecting instrumentalities for separating said wires of said pairs and for guiding the projecting end portions of said wires past said severing means whereby, upon positioning one wire of each pair in each of said connecting instrumentalities with end portions of said wires extending through said instrumentalities, and upon actuating said instrumentalities, end portions of said wires are trimmed and said corresponding wires of said pairs are electrically connected to each other.

2. Apparatus as set forth in claim 1 wherein said connecting instrumentalities comprise crimping means for crimping open U-type connectors onto said wires.

3. Apparatus as set forth in claim 2 including guide means between said two crimping means for selectively guiding one wire of each pair into each of said crimping means and for selectively guiding the projecting end portions of said wires through said severing means.

4. Apparatus as set forth in claim 2 including guide means between said two crimping means for selectively guiding one wire of each pair into each of said crimping means, for selectively guiding the portions of said wires extending through said crimping means in side-by-side parallel relationship without crossing, and for guiding the end portions of said wires through said severing means.

5. Apparatus for connecting the corresponding ends of a first and second pair of wires to each other comprising, two crimping die members and two crimping anvil members, one of said die members and one of said anvil members constituting a first crimping means, the other of said die members and the other of said anvil members constituting a second crimping means, said first and second crimping means extending parallel to each other in side-by-side relationship, said members of each crimping means being normally spaced apart, means for moving said members of each crimping means relatively towards each other, each crimping means having at each end thereof severing blade means, said severing blade means being movable relatively past one of said members of its crimping means whereby, upon positioning each set of corresponding ends of said wires in one of said crimping means with the end portions of said wires extending between one of said severing blade means and said one of said members, and upon moving said ones of said members relatively past said severing blade means and subsequently moving said members of each crimping means towards each other, said end portions are trimmed and connectors are crimped onto said wires.

6. Apparatus as set forth in claim 5 wherein said anvil members are disposed back to back and face in opposite directions.

7. Apparatus as set forth in claim 5 including guide means on each side of said first and second crimping means for guiding all of said wires selectively past a nonsevering side of said blade means thence between a die means and anvil means thence past a severing side of a blade means and for positioning said wires in each of said crimping means in parallel noncrossing relationship to each other.